

WHAT IS CLAIMED IS:

1. A lane keep control apparatus for an automotive vehicle, comprising:

5 a traffic lane detecting section that detects a traffic lane on which the vehicle is running;

a traveling state detecting section that detects a traveling state of the vehicle;

10 a deviation determining section that determines whether the vehicle has a tendency to be deviated from the traffic lane according to the traffic lane detected by the traffic lane detecting section and the traveling state of the vehicle detected by the traveling state detecting section; and

15 a vehicular behavior controlling section that controls a behavior of the vehicle in such a manner that a yaw moment of the vehicle is developed in a direction to avoid a deviation of the vehicle from the traffic lane in accordance with the traveling  
20 state detected by the traveling state detecting section when the deviation determining section determines that the vehicle has a tendency of the deviation of the vehicle from the traffic lane, the traffic lane detecting section including a lane  
25 marker detecting section that detects lane markers, each lane marker representing one side of the traffic lane, and the vehicular behavior controlling section controlling the behavior of the vehicle on the basis of the detected lane marker at one side of the  
30 traffic lane when the lane marker detecting section transfers a detection state from a state in which both of the lane markers at both sides of the traffic

lane are detected to a state in which the lane marker only at one side of the traffic lane is detected.

2. A lane keep control apparatus for an automotive  
5 vehicle, as claimed in claim 1, further comprising a  
lane marker certainty detecting section that detects  
a certainty of the traffic lane of the vehicle  
detected by the lane marker detecting section and  
wherein the vehicular behavior controlling section  
10 controls the behavior of the vehicle on the basis of  
a certainty of the lane marker detected by the lane  
marker certainty detecting section when the lane  
marker detecting section transfers the detection  
state from the state in which both of the lane  
15 markers at both sides of the traffic lane are  
detected to the state in which the lane marker only  
at one side of the traffic lane is detected.

3. A lane keep control apparatus for an automotive  
20 vehicle, as claimed in claim 2, wherein the lane  
marker certainty detecting section detects the  
certainty of the lane marker on the basis of a  
continuation time for which the lane marker is  
detected by the lane marker detecting section.

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4. A lane keep control apparatus for an automotive  
vehicle, as claimed in claim 2, wherein the lane  
marker detecting section detects the lane marker at a  
plurality of different regions on a photographed  
30 image and specifies a representative position of the  
lane marker at each of the regions and wherein the  
lane marker certainty detecting section detects the  
certainty of the lane marker on the basis of the

number of specified representative positions of the lane marker on the respective regions detected by the lane marker detecting section.

5 5. A lane keep control apparatus for an automotive vehicle, as claimed in claim 1, wherein the vehicular behavior controlling section reduces a control output smaller than the control output at a time at which both of the lane markers located at both sides of the traffic lane are detected, when the lane marker  
10 detecting section transfers the detection state from the state in which both of the lane markers at both sides of the traffic lane are detected to the state in which the lane marker only at one side of the  
15 traffic lane is detected.

6. A lane keep control apparatus for an automotive vehicle, as claimed in claim 5, wherein the vehicular behavior controlling section reduces a  
20 controlled output by modifying a control gain.

7. A lane keep control apparatus for an automotive vehicle, as claimed in claim 5, wherein the vehicular behavior controlling section reduces a  
25 controlled output by modifying a control threshold value ( $X_c$ ).

8. A lane keep control apparatus for an automotive vehicle, as claimed in claim 1, wherein the  
30 vehicular behavior controlling section includes a braking/driving force controlled variable calculating section that calculates a driving force controlled variable for each road wheel of the vehicle to

develop the yaw moment in a direction avoiding the deviation of the vehicle from the traffic lane and braking/driving force controlling section that controls the driving force applied to each road wheel  
5 in accordance with the driving force controlled variable calculated by the braking/driving force controlled variable calculating section.

9. A lane keep control apparatus for an automotive  
10 vehicle, as claimed in claim 2, wherein the lane marker detecting section comprising a lane marker detection area setting section that sets a lane marker detection area on the basis of a steering angle  $\delta$  of the vehicle and the lane marker detecting  
15 section detects the lane markers at both sides of the traffic lane on the basis of the lane marker detection area.

10. A lane keep control apparatus for an automotive  
20 vehicle, as claimed in claim 9, wherein the traffic lane detecting section detects the traffic lane on which the vehicle is traveling using the lane markers at both sides in the lane marker detection area.

25 11. A lane keep control apparatus for an automotive vehicle, as claimed in claim 2, further comprising: a one-side lane marker presence determining section that determines whether the lane marker only at one side of the traffic lane is detected when both-side  
30 lane markers are not detected and wherein the lane marker certainty detecting section comprises a both-side lane marker presence determining section that determines whether, at a previous process of a

vehicular behavior control, the lane markers at both sides of the traffic lane have been detected when the one-side lane marker determining section determines that the lane marker only at one side of the traffic  
5 lane is detected.

12. A lane keep control apparatus for an automotive vehicle, as claimed in claim 11, wherein, when the both-side lane marker presence determining section  
10 determines that, at the previous process of the vehicular behavior control, the lane markers at both sides of the traffic lane have been detected, the vehicular behavior controlling section comprises: a future lateral displacement calculating section that  
15 calculates a future estimated lateral displacement  $X_S$  in accordance with a yaw angle  $\phi$  of the vehicle with respect to the traffic lane, a lateral displacement  $X$  from a center of the traffic lane, a curvature  $\beta$  of the traffic lane, and a vehicular velocity  $V$  of the  
20 vehicle and wherein the deviation determining section determines whether the vehicle has the tendency of the deviation of the vehicle from the traffic lane according to whether an absolute value of the future estimated lateral displacement  $|X_S|$  is equal to or  
25 greater than a predetermined lateral displacement limit value  $X_c$ .

13. A lane keep control apparatus for an automotive vehicle, as claimed in claim 12, wherein the  
30 vehicular behavior controlling section comprises a target yaw moment calculating section that calculates a target yaw moment  $M_s$  using a proportional coefficient  $K_1$  determined according to vehicle

specifications, another proportional coefficient  $K_2$  set in accordance with a vehicular velocity  $V$ , calculated lateral displacement  $X_S$ , and the predetermined lateral displacement limit value  $X_c$  when the deviation determining section determines that the vehicle has the tendency of the deviation of the vehicle from the lane.

14. A lane keep control apparatus for an automotive vehicle, as claimed in claim 13, wherein the vehicular behavior controlling section comprises a target yaw moment magnitude dependent braking force calculating section that calculates a front left-and-right wheel braking liquid pressure difference  $\Delta P_{SF}$  to be zeroed and a rear left-and-right wheel braking fluid pressure difference  $\Delta P_{SR}$  to be given as follows:  $\Delta P_{SR} = 2 \times K_{bR} \times |M_s|/T$ , wherein  $K_{bR}$  denotes a predetermined conversion coefficient to convert a braking force into a braking fluid pressure and  $T$  denotes a tread of the vehicle, when the magnitude of the target yaw moment  $|M_s|$  is smaller than a predetermined yaw moment  $M_{s0}$  and calculates the front left-and-right wheel braking liquid pressure difference  $\Delta P_{SF}$  to be given as follows:  $\Delta P_{SF} = 2 \times K_{bF} \times (|M_s| - M_{s0})/T$ , and the rear left-and-right wheel braking fluid pressure difference  $\Delta P_{SR}$  to be given as follows:  $\Delta P_{SR} = 2 \times K_{bR} \times (|M_{s0}|)/T$ .

15. A lane keep control apparatus for an automotive vehicle, as claimed in claim 14, wherein, when the target yaw moment  $M_s$  is a negative value, a target braking liquid fluid pressure for each wheel cylinder of front left and right road wheels and rear left and

right road wheels  $P_{sFL}$ ,  $P_{sFR}$ ,  $P_{sRL}$ , and  $P_{sRR}$  are as follows:  $P_{sFL} = P_m$ ,  $P_{sFR} = P_m + \Delta P_{SF}$ ,  $P_{SEL} = P_m$ , and  $P_{sRR} = P_m + \Delta P_{SR}$ , wherein  $P_m$  denotes a master wheel cylinder fluid pressure.

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16. A lane keep control apparatus for an automotive vehicle, as claimed in claim 14, wherein, when the target yaw moment  $M_s$  is a positive value, a target braking liquid fluid pressure for each wheel cylinder  
10 of front left and right road wheels and rear left and right road wheels  $P_{sFL}$ ,  $P_{sFR}$ ,  $P_{sRL}$ , and  $P_{sRR}$  are as follows:  $P_{sFL} = P_m + \Delta P_{SF}$ ,  $P_{sFR} = P_m$ ,  $P_{SEL} = P_m + \Delta P_{SR}$ , and  $P_{sRR} = P_m$ , wherein  $P_m$  denotes a master wheel cylinder pressure.

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17. A lane keep control apparatus for an automotive vehicle, as claimed in claim 16, wherein the vehicular behavior controlling section calculates and outputs a target drive torque  $Trq_{Ds}$  depending upon  
20 the determination of the deviation determining section that the vehicle has the tendency to be deviated from the traffic lane and according to the front and rear left-and-right fluid pressure differences  $\Delta P_{SF}$  and  $\Delta P_{SR}$  and wherein the target  
25 drive torque is outputted to a drive controller.

18. A lane keep control apparatus for an automotive vehicle, as claimed in claim 11, wherein the lane marker detecting section comprises a lane marker  
30 counter that increments whenever the both-side lane markers are detected in the lane marker detection area and wherein, when a count value of the lane marker counter (CNT) is equal to or larger than a

preset value  $CNT_0$ , the vehicular behavior controlling section controls the behavior of the vehicle in such a manner that the yaw moment is developed in the direction to avoid the deviation of the vehicle from the traffic lane.

19. A lane keep control apparatus for an automotive vehicle, comprising:

traffic lane detecting means for detecting a traffic lane on which the vehicle is running;

traveling state detecting means for detecting a traveling state of the vehicle;

deviation determining means for determining whether the vehicle has a tendency to be deviated from the traffic lane according to the traffic lane detected by the traffic lane detecting means and the traveling state of the vehicle detected by the traveling state detecting means; and

vehicular behavior controlling means for controlling a behavior of the vehicle in such a manner that a yaw moment of the vehicle is developed in a direction to avoid a deviation of the vehicle from the traffic lane in accordance with the traveling state detected by the traveling state detecting means when the deviation determining means determines that the vehicle has a tendency of the deviation of the vehicle from the traffic lane, the traffic lane detecting means including lane marker detecting means for detecting lane markers, each lane marker representing one side of the traffic lane, and the vehicular behavior controlling means controlling the behavior of the vehicle on the basis of the detected lane marker at one side of the traffic lane



when the lane marker detecting section transfers a detection state from a state in which both of the lane markers at both sides of the traffic lane are detected to a state in which the lane marker only at  
5 one side of the traffic lane is detected.

20. A lane keep control method for an automotive vehicle, comprising:

detecting a traffic lane on which the vehicle is  
10 running;

detecting a traveling state of the vehicle;

determining whether the vehicle has a tendency to be deviated from the traffic lane according to the detected traffic lane and the detected traveling  
15 state of the vehicle; and

controlling a behavior of the vehicle in such a manner that a yaw moment of the vehicle is developed in a direction to avoid a deviation of the vehicle from the traffic lane in accordance with the detected  
20 traveling state when determining that the vehicle has a tendency of the deviation of the vehicle from the traffic lane, during the traffic lane detection, detecting lane markers, each lane marker representing one side of the traffic lane, and  
25 controlling the behavior of the vehicle on the basis of the detected lane marker at one side of the traffic lane, when a detection state is transferred from a state in which both of the lane markers at both sides of the traffic lane are detected to a  
30 state in which the lane marker only at one side end of the traffic lane is detected.